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DECLARATION

In the matter of Patent Application
In the U.S. in the name of
KABUSHIKI KAISHA TOSHIBA

I, the undersigned, Ryutaro HAYAKAWA, of Tokyo International Patent Firm, of 17-16, Nishi-Shimbashi 1-Chome, Minato-Ku, Tokyo, Japan, do solemnly and sincerely declare as follows:

1. That I am well acquainted with the English and Japanese languages and am competent to translate from Japanese into English.
2. That I have executed, with the best of my ability, a true and correct translation into English of the attached Certified Copy of the complete specification and claims originally filed as Japanese Patent Application No. 124819/2000 filed on April 25, 2000.

Dated this 2nd day of July, 2004

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[Name of document] Specification

[Title of the invention] MRI system involving movement of patient's couch

[Claims]

[Claim 1] An MRI system comprising scan means for applying, to a region to be imaged of an object placed in a uniform static magnetic field, RF waves and gradient magnetic fields in accordance with a predetermined pulse sequence, characterized in that the system is provided with

couch moving means for moving a couch on which the object is laid;

at least one or more reception RF coils;

scan controlling means for controlling operations of both the scan means and the couch moving means so that the same region to be imaged of the object is scanned at a plurality of different positions of the couch; and

image producing means for producing MR images from MR signals received by the reception RF coils.

[Claim 2] The MRI system according to claim 1, wherein the reception RF coils consist of one or more whole-body coils.

[Claim 3] The MRI system according to claim 1, wherein the reception RF coils consist of a plurality of multiple RF coils.

[Claim 4] The MRI system according to either claim 2 or 3, wherein the scan controlling means is means for controlling the operations of both the scan means and the couch moving means so as to execute the scan at the plurality of different positions of the couch with the number of encodes less than the number of encodes necessary for production of one image and

the image producing means is means for producing the MR image using the MR signals received from the same region to be imaged through the reception RF coils at the plurality of positions.

[Claim 5] An MRI system comprising scan means for applying, to a region to be imaged of an object placed in a uniform static magnetic field, RF waves and gradient magnetic fields in accordance with a predetermined pulse sequence, characterized in that the system is provided with

couch moving means for moving a couch on which the object is laid;

a plurality of reception RF coils;

scan controlling means for controlling operations of both the scan means and the couch moving means so that a region to be imaged of the object is scanned at a plurality of different positions of the couch;

selection means for selecting, from a plurality of MR signals received by the plurality of reception RF coils, an MR image used for image production; and

image producing means for producing an MR image from the MR signal selected by the selection means.

[Claim 6] The MRI system according to claim 5, wherein the selection means is provided with a signal selection means for selecting the signal used for the image production from the plurality of MR signals received by the plurality of reception RF coils on the basis of a control signal given in response to an movement the couch.

[Claim 7] The MRI system according to claim 5, wherein the selection means is provided with signal level detection means for detecting levels of the MR signals received by the plurality of reception RF coils and a signal selection means for selecting the signal used for the image production from the plurality of MR signals received by the plurality of reception RF coils on the basis of changes in the levels of the MR signals detected by the signal level detection means.

[Claim 8] An MRI system comprising scan means for applying, to a region to be imaged of an object placed in a uniform static magnetic field, RF waves and gradient magnetic fields in accordance with a predetermined pulse sequence, characterized in that the system is provided with

couch moving means for moving a couch on which the object is laid;

a plurality of reception RF coils;

ID generating means, which is provided with the plurality of reception RF coils, for generating ID numbers inherent to the reception coils;

size memorizing means for memorizing sizes in a couch-longitudinal direction of the reception RF coils, the sizes

corresponding to the ID numbers generated by the ID generating means;

disposal detecting means for recognizing each of signal lines coming from the plurality of reception RF coils and for detecting disposal states of the plurality of reception RF coils in the couch-longitudinal direction;

determination means for determining the sizes by making reference to the size memorizing means on detection information about the coil disposal sates detected by the disposal detecting means;

scan controlling means for scanning the region to be imaged of the object at a plurality of different positions of the couch by controlling operations of both the scan means and the couch moving means based on the sizes determined by the determining means;

selection means for selecting, of a plurality of MR signals received by the plurality of reception RF coils, an MR signal used for imaging production on the basis of both of the sizes determined by the determination means the coil disposal states detected by the disposal detecting means; and

image producing means for producing an MR image from the MR signal selected by the selection means.

[Detailed description of the invention]

[0001]

[Technical filed to which the invention pertains]

The present invention relates to a magnetic resonance imaging (MRI) system and a magnetic resonance imaging method, which are used for medical purposes, and in particular, to the system and the method that use multiple RF coils serving as an RF coil for receiving MR signals and enable fast imaging with a couch (tabletop) on which a patient (object to be imaged) is laid.

[0002]

[Prior art]

Magnetic resonance imaging is a technique for magnetically exciting nuclear spins in an object located in a static magnetic field by applying a radio-frequency (RF) signal with the Larmor frequency, and reconstructing an image of the object using an FID (free induction decay) signal or echo signal induced by the excitation. In the magnetic

resonance imaging, like imaging that uses other modalities, a wide variety of imaging techniques have been developed thanks to recent advancements in hardware.

[0003]

For example, for imaging blood vessels in the inferior limb, various imaging techniques have already known. Normally, imaging the inferior limb requires an imaged region to be wider in the body axis direction. Further, it is also required that imaging in such a wider range be finished during an interval of time during which a contrast agent remains in the inferior limb. Hence imaging should be done at a higher speed (in a shorter time) and in a higher temporal resolution.

[0004]

One technique, which is able to have a wider imaging range, is a patient's couch moving imaging technique, called a moving bed technique, by which the imaging is done with a patient's couch moved. When this technique is used, the first scan for a given region is conducted at a certain patient's couch location, the couch (patient) is moved by a distance corresponding to the given region, and then the second scan is conducted for the next region to be imaged. This combination of scans and couch movements is repeated in turn, so that a desired region to be imaged, such as the inferior limb, is entirely covered. After the imaging, the obtained images are lined up in, for example, the body axis direction or combined into a single image to be used for diagnosis.

[0005]

The moving bed technique includes a technique that uses a whole-body coil with the couch moved and a technique that uses multiple RF coils.

[0006]

In the case of the technique involving the whole-body coil, the whole-body coil is fixed to a magnet. The couch is moved stepwise by a distance equal to a predetermined region to be imaged, and after each movement to a new region to be imaged, imaging is done.

[0007]

Fig. 12 exemplifies an MRI system capable of performing the moving bed technique by which a whole-body coil 101 is used. In the

figure, a reference 102 is a magnet that generates a static magnetic field. Connected to the whole-body coil 101 through a duplexer 103 are a transmitter 104 and a preamplifier 105. The preamplifier 105 is connected to a receiving-system circuit 106, both of which make up a receiver. A host computer 107 responsible for control of the whole system is placed to control a transmitter 104 and a gradient amplifier 109 via a sequencer 108, so that a given pulse sequence is performed. Connected to the host computer 107 are an input device 109, display 110, and storage 111. The host computer 107 controls a not-shown couch driver to move a tabletop 112 of the couch based on the moving bed technique.

[0008]

On the other hand, when the technique using multiple RF coils is performed, the multiple RF coils themselves are fixed to an object or the couch, so the coil can be moved with the couch. The multiple RF coils consist of, for example, a plurality of sets of coil members (a coil group) disposed in an array. In this case, in response to movement of the couch under imaging, each set of coil members enters a uniform static field region within a magnet's bore, and then exists therefrom.

[0009]

When it is desired to use the multiple RF coils based on the moving bed technique, it is conceivable that a plurality of images obtained through a plurality of sets of coil elements are made to cover all of a desired region to be imaged of an object.

[0010]

Fig. 13 exemplifies an MRI system that is able to execute the moving bed technique with such multiple RF coils. The multiple RF coils 121 consist of three sets of coil members 1 to 3. Each set of the coil members 1 to 3 is independently routed to a host computer 107 through a preamplifier 105a to 105c and a receiving-system circuit 106a to 106c, respectively. That is, the multi RF coil 121 and the circuitry to receiver and process detected signals of the coil are added to the constitution shown in Fig. 12.

[0011]

Meanwhile, to meet the foregoing requirements of shortening the imaging time, higher-performance technologies in the hardware, as in

improvement of a booster technology to shorten a switchover time of gradients, are now under development.

[0012]

As another imaging technique, high-temporal-resolution dynamic imaging has been known for observing the passage of a contrast agent at high temporal resolution. This imaging includes a key-hole imaging technique and a view share (View Share) technique. When the key-hole imaging technique is used, data for one image are previously acquired, and then dynamic imaging is done, during which time only data mapped in a central part of the k-space used for image reconstruction are updated. Meanwhile, the view share technique, which abandons the procedures of updating all the k-space with new data before reconstructing the k-space into a new image, uses the k-space previously divided in a plurality of regions. And an image is reconstructed whenever a plurality of divided regions of the k-space are partly replaced with new acquired data, thus raising an image update rate. Another imaging technique has been known which is called 3D-Triks, which is provided by improving the key-hole imaging technique to 3D MRA. The central part of the k-space is therefore raised in the data update rate than the remaining region, so that the key-hole imaging technique is effective in observing the passage of a contrast agent at higher temporal resolution than that of the normal view share technique.

[0013]

[Problem to be solved by the invention]

However, of the foregoing various types of prior art, in the case of using the moving bed technique that involves the multiple RF coils to widen a region to be imaged, it is required that a plurality of sets of coil elements be switched over to select one set located at the uniform static field region whenever the couch is moved by an amount corresponding to the length of a region to be imaged. In order to realize this, as an operator observes the couch that is under stepwise movement, the operator should manually switch one set of coil elements to another set. This complicates operations and lacks accuracy, in addition to taking much time.

[0014]

Further, the current hardware techniques are still short when realizing both of the shortened imaging time and the higher temporal resolution. The foregoing key-hole imaging and other imaging techniques are still short of temporal resolution. In addition, the foregoing imaging techniques such as the key-hole imaging is simply nothing but raising apparent temporal resolution by updating data mapped in part of the k-space, thus lacking a depiction performance of minute structures. Still, the foregoing imaging techniques such as the key-hole imaging can be applied only to a situation that a region to be imaged of an object is constant and changes of intensity at part of the region to be imaged, which is due to a contrast agent, are observed. But those techniques are unavailable for imaging that requires the couch to be moved such that different regions are sequentially subject to imaging at a high speed.

[0015]

Recently, concerning this fast imaging, a technique of gaining a shortened imaging time by using multiple RF coils has been spotlighted (for example, refer to "10th Ann. Scientific Meeting SMRM 1240 (1991)," which is effective in speeding up approximately all types of magnetic resonance imaging techniques. This technique enables imaging to be performed with less number of encoding steps necessary for reconstructing a single image. The resultant folded data is dissolved based on the fact that a plurality of coil elements constituting the multiple RF coils are different in their sensitivity distributions from each other, so that images with no folded data are obtained. Since this fast imaging allows the number of encoding steps to be lessened in proportion to the number of coil elements, unlike the ordinal imaging methods, the imaging time can be shortened.

[0016]

However, the moving bed technique involving a single whole-body coil cannot be applied to such fast imaging. Further, in cases the moving bed technique involving multiple RF coils is applied to the fast imaging, it is necessary that an operator switch a plurality of sets of coil elements (sets), as described before, with the operator recognizing amounts of movement of the couch. This means that the fast imaging cannot provide its merits satisfactorily.

[0017]

The present invention has been made to overcome the current conditions owned by the foregoing imaging techniques. A first object of the present invention is to reduce operational work, speed up imaging, and increasing accuracy in moving a patient' s couch in cases multiple RF coils are used as a reception RF coil so as to perform imaging based on the moving bed technique (method of moving the couch).

[0018]

A second object of the present invention is to easily perform the fast imaging with improved temporal resolution, so that MR images of which depiction performance is improved are provided, in cases multiple RF coils are used as a reception RF coil so as to perform imaging based on the moving bed technique.

[0019]

[Means for solving problem]

In order to accomplish the above objects, the present invention is provided, as one aspect, to have an MRI system comprising scan means for applying, to a region to be imaged of an object placed in a uniform static magnetic field, RF waves and gradient magnetic fields in accordance with a predetermined pulse sequence, characterized in that the system is provided with couch moving means for moving a couch on which the object is laid; at least one or more reception RF coils; scan controlling means for controlling operations of both the scan means and the couch moving means so that the same region to be imaged of the object is scanned at a plurality of different positions of the couch; and image producing means for producing MR images from MR signals received by the reception RF coils.

[0020]

For example, the reception RF coils consist of one or more whole-body coils or a plurality of multiple RF coils.

[0021]

In this case, preferably, the scan controlling means is means for controlling the operations of both the scan means and the couch moving means so as to execute the scan at the plurality of different positions of the couch with the number of encodes less than the number of encodes necessary for production of one image and the

image producing means is means for producing the MR image using the MR signals received from the same region to be imaged through the reception RF coils at the plurality of positions.

[0022]

Moreover, the MRI system according to the present invention can be provided with, as another mode, couch moving means for moving a couch on which the object is laid; a plurality of reception RF coils; scan controlling means for controlling operations of both the scan means and the couch moving means so that a region to be imaged of the object is scanned at a plurality of different positions of the couch; selection means for selecting, from a plurality of MR signals received by the plurality of reception RF coils, an MR image used for image production; and image producing means for producing an MR image from the MR signal selected by the selection means.

[0023]

In this configuration, preferably, the selection means is provided with a signal selection means for selecting the signal used for the image production from the plurality of MR signals received by the plurality of reception RF coils on the basis of a control signal given in response to an movement the couch. Alternatively, the selection means may be provided with signal level detection means for detecting levels of the MR signals received by the plurality of reception RF coils and a signal selection means for selecting the signal used for the image production from the plurality of MR signals received by the plurality of reception RF coils on the basis of changes in the levels of the MR signals detected by the signal level detection means.

[0024]

Moreover, as another mode of the MRI system according to the present invention, the system can be provided with couch moving means for moving a couch on which the object is laid; a plurality of reception RF coils; ID generating means, which is provided with the plurality of reception RF coils, for generating ID numbers inherent to the reception coils; size memorizing means for memorizing sizes in a couch-longitudinal direction of the reception RF coils, the sizes corresponding to the ID numbers generated by the ID generating means; disposal detecting means for recognizing each of signal lines

coming from the plurality of reception RF coils and for detecting disposal states of the plurality of reception RF coils in the couch-longitudinal direction; determination means for determining the sizes by making reference to the size memorizing means on detection information about the coil disposal sates detected by the disposal detecting means; scan controlling means for scanning the region to be imaged of the object at a plurality of different positions of the couch by controlling operations of both the scan means and the couch moving means based on the sizes determined by the determining means; selection means for selecting, of a plurality of MR signals received by the plurality of reception RF coils, an MR signal used for imaging production on the basis of both of the sizes determined by the determination means the coil disposal states detected by the disposal detecting means; and image producing means for producing an MR image from the MR signal selected by the selection means.

[0025]

More practical configurations and features according to other modes of the present invention will be made clear from the following embodiments and the appended drawings hereto.

[0026]

[Embodiments for the invention]

Referring to the accompanying drawings, embodiments of the present invention will now be explained.

[0027]

(First embodiment)

Referring to Fig. 1, an MRI (magnetic resonance imaging) system of a first embodiment will now be described.

[0028]

The MRI system performs imaging using multiple RF coils with a couch moved (that is, a moving bed technique).

[0029]

The configuration of this MRI system is outlined in Fig. 1. This system has a couch unit on which a patient P as an object to be imaged, a static magnetic field generating unit for generating a static magnetic field, and a gradient generating unit for adding position information to the static magnetic field. The system also has a

transmission/reception unit for transmitting and reception RF signals and a control/calculation unit in charge of control of the entire system and image reconstruction.

[0030]

The static magnetic generation unit is proved with a magnet 1 constructed by employing for example a superconducting magnet and a static power supply 2 supplying current to the magnet 1. By these devices, a static magnetic field H_0 is produced in an axial direction of a cylindrical bore (a space for diagnosis) into which the object P is inserted. In the orthogonal coordinate axes assigned to the system, such direction agrees with the Z-axis direction. In addition, this generation unit is provided with a not-shown shimming coil to which current is supplied from a shimming coil power supply to shim the static magnetic field. This supply of current forms a region in which the static magnetic field is kept to in magnitude within a certain range of uniformity, that is, a region for diagnosis.

[0031]

The couch unit is configured in such a manner that a tabletop 14T on which the object P is laid can be inserted and returned into and from the bore of the magnet 1. A couch driver 14D does this insertion and return. The couch driver 14D responds to a drive signal given by a host computer 6 later described so as to move the tabletop 14T along its longitudinal direction (i.e., the Z-axis direction). The object P is laid on the tabletop 14T along its longitudinal direction, for example.

[0032]

The gradient generating unit has a not-shown gradient coil unit incorporated in the magnet 1. The gradient coil unit includes three sets (types) of x-, y-, and z-coil for generating X-, Y-, and Z-directional gradient magnetic fields (gradients) orthogonal among themselves. The gradient generating unit further includes a gradient amplifier 4 to supply currents to each of the x-, y-, and z-coils. The amplifier 4 supplies those coils with pulsed currents to generate gradients under the control of a sequencer 5 later described.

[0033]

Controlling pulsed currents supplied from the gradient amplifier 4 to the x-, y-, and z-coils enables the mutually-orthogonal X-, Y-, and

Z-directional gradients, which are gradients in the physical axes, to be synthesized. Thus mutually-orthogonal logic directional gradients, i.e., a slice gradient Gs, phase-encode gradient Ge, and read-out (frequency encoding) gradient Gr can be set or changed in an arbitrary way. The gradients in the slice, phase-encode, and read-out directions are superposed on the static field H_0.

[0034]

The transmission/reception unit includes a whole-body (WB) coil 7T and multiple RF coils 7R, both of which are RF coils, and a transmitter 8T and a receiver 8R both connected to the coils 7T and 7R. The coils 7T and 7R are disposed in the vicinity of the object P in the space for diagnosis formed within the bore of the magnet 1.

[0035]

The whole-body coil 7T is used in common for transmission and reception in cases only the coil 7T is employed as the RF coil. By contrast, when employing the multiple RF coils 7R (serving as a reception coil), the whole-body coil 7T is used as a transmission coil.

[0036]

The multiple RF coils 7R, formed as an array type of coil to which a high S/N ratio can be given, are disposed in turn in the region in which the static field is uniform (region for diagnosis), so that imaging can be done using the moving bed technique. The multiple RF coils 7R are formed by at least one array coil (each array coil consists of a plurality of coil elements, which are called "coil group" in this embodiment). Each array coil constitutes the coil member according to the present invention. By way of example, the multiple RF coils 7R according to the present embodiment are formed three coil groups 1 to 3 disposed on the tabletop 14T of the couch. Each coil group 1 (to 3) is an array type of coil in which a plurality of coil elements are arranged. The coil groups 1 to 3 can be mounted on the object. The output lines of the three groups 1 to 3 are, separately from each other and coil element by coil element, connected to the host computer 6. Thus the output signal from each coil element is supplied to the host computer 6 independently of each other.

[0037]

Both of the transmitter 8T and the receiver 8R are operative

under the control of a sequencer 5 later described. The transmitter 8T supplies to the whole-body coil 7T RF pulsed currents of which frequency is set to a Larmor frequency to cause nuclear magnetic resonance (NMR) at magnetic spins of the object P. On the other hand, the receiver 8R accepts an echo signal (RF signal) received by the whole-body coil 7T or multiple RF coils 7R, then makes it into echo data (i.e., raw data).

[0038]

Specifically, the receiver 8R is divided, as shown in Fig. 1, into a reception part for the whole-body coil and a further reception part for the multiple RF coils.

[0039]

The reception part for the whole-body coil includes a duplexer 81 connected with the whole-body coil 7T, a preamplifier 82 connected to the duplexer 81, and a receiving-system circuit 83 receiving a reception signal from the preamplifier 82. The duplexer 81 is coupled with the transmitter 8T as well.

[0040]

This connection permits the duplexer 81 to pass a transmission drive pulse from the transmitter 8T to the whole-body coil 7T in transmission, while to pass an echo signal detected by the whole-body coil 7T to the preamplifier 82 in reception. The preamplifier 82 pre-amplifies the received echo signal to send the amplified signal to the receiving-system circuit 83. This circuit 83 performs various types of signal processing on the inputted echo signal, the processing including intermediate frequency conversion, phase detection, low-frequency amplification, and filtering. Then, the processed signal is subject to A/D conversion to produce echo data (raw data), before being sent to the host computer 6.

[0041]

On the other hand, the reception part for the multiple RF coils is provided with preamplifier groups 84A to 84C receiving echo signals form the multiple RF coils 7R every coil group 1 (to 3) and every coil element. The output lines from each preamplifier group 84A (to 84C) are routed to an input switchover unit 86 via each connector box 85A (to 85C) to which the lines can be connected detachably. Connected

positions (or a connection order) of the preamplifier groups 84A to 84C to the connector boxes 85A to 85C are determined in advance.

[0042]

The input switchover unit 86 is for example composed of a multiplexer and switched over in response to a switchover control signal SS that the host computer 6 gives. Accordingly, the input switchover unit 86 is able to selectively switch any one of the signals that the preamplifiers 84A to 84C produce and to send out the selected signal through its output terminal. The output terminal of the input switchover unit 86 is then sent to the host computer 6 via a further receiving-system circuit 87. In the similar way to the above, this circuit 87 executes various types of processing, such as intermediate frequency conversion, phase detection, low-frequency amplification, and filtering, on the inputted echo signal. Further, the circuit 87 A/D-converts the processed echo signal to produce echo data, then sends the converted one to the host computer 6.

[0043]

Moreover, the control/calculation unit includes a sequencer 5 (also called a sequence controller), host computer 6, storage 11, display 12, and input device 13.

[0044]

The host computer 6 provides the sequencer 5 with pulse sequence information on the basis of procedures on software stored in its inner memory or the storage 11 and controls the operations of the entire system. Additionally, the host computer 6 has various functions of calculating image data through reconstruction processing of echo data and controlling the drive of the couch driver 14D. The host computer 6 further includes a function of selectively switching over the input switchover unit 86 by giving a switchover control signal SS thereto every time when, of a plurality of times of imaging, one imaging is switched over to another. This switchover function is previously determined by the software procedures so that the input/output paths of the input switchover unit 86 are switched over in a predetermined order.

[0045]

The imaging scan is carried out on the imaging pulse

information in order to acquire a set of echo data necessary for image reconstruction. The pulse sequence uses either a three-dimensional (3D) scan or a two-dimensional (2D) scan. As modes of trains of pulses which can be employed, provided are an SE (spin echo) method, FSE (fast spin echo) method, FASE (fast asymmetric SE) method (that is, the FSE method combined with a half-Fourier method), EPI (echo planar imaging) imaging, FE (gradient field echo) method, FFE (fast FE) method, segmented FFE method, and others.

[0046]

The sequencer 5 has a CPU and memories and memorizes pulse sequence information sent from the host computer 6. Based on this information, the sequencer 5 controls the operations of the gradient amplifier 4, transmitter 8T, and receiver 8R. The pulse sequence information is all kinds of information necessary for operating the gradient amplifier 4, transmitter 8T, and receiver 8R according to a series of pulse sequence. For instance, the pulse sequence information includes pieces of information concerning magnitudes of pulsed currents applied to the x-, y-, and z-coil, duration of application of the pulses, and application timing.

[0047]

Echo data (original data or raw data) processed by the receiver 8R are sent to the host computer 6, which has a function of image reconstruction on the basis of a predetermined calculation program. Therefore, the host computer 6 uses its calculation function to map echo data given by the receiver 8R in a Fourier space (referred to as a k-space or frequency space) formed by its inner memory. The host computer 6 carries out a two- or three-dimensional Fourier transform on each set of echo data, so that image data in the real space are reconstructed. The image data are then subjected to a display action conducted by the display 12 as well as stored by the storage 11. Imaging conditions, the type of a pulse sequence, and information with regard to image synthesis or subtraction are provided to the host computer 6 via the input put 13 depending on operator's desire.

[0048]

In this magnetic resonance imaging, the imaging (scanning) that uses the moving bed technique is carried out as below.

[0049]

At first, the tabletop 14T is moved such that the center of the first coil group 1 in the Z-axial direction agrees with the center of the uniform region of the static field in the Z-axial direction. Responsively to this location, the host computer 6 provides the input switchover unit 86 with the switchover control signal SS, so that its input-side switchover terminal is switched over to "1," that is, the side of the connector box 85A (i.e., the preamplifier group 84A).

[0050]

At this tabletop position and this switch's switchover position, the first scan is performed based on pulse sequence information given by the sequencer 5. This scan allows all echo signals acquired from the all the coil groups 1 to 3 via the multiple RF coils 7R to be sent to the receiver 8R. However, since the input path of the input switchover unit 86 in the receiver 8R is switched over to only the side of the coil group 1, an echo signal acquired by the coil group 1 is solely sent to the receiving-system circuit 87.

[0051]

Thus the echo signal detected by the coil group 1 is received and processed by the receiving-system circuit 87, with the result that the echo signal is converted to echo data, and then sent to the host computer 6. In other words, of the echo signals detected by the all the coil groups 1 to 3, only an echo signal emanated from any coil group present in the uniform region of the static field is processed and sent to the host computer 6.

[0052]

The host computer 6 performs reconstruction processing of echo data corresponding to the echo signal detected by the coil group 1. Real-space image data of a slice or slab of the object P are thus obtained, and temporarily stored in its inner memory of the host computer 6 or the storage 11.

[0053]

Then, in order to cope with the second imaging (scan), the tabletop 14T of the couch (i.e., the object P) is moved by a distance corresponding to a region required for one time of imaging in the Z-axis direction. Thus the second coil group 2 is located in the central part of

the uniform region of the static field in the Z-axis direction. Namely, in cases where all the coil groups 1 to 3 is the same in size, an amount of movement of the tabletop in the Z-axis direction is the same whenever each time of imaging is carried out. Responsively to this positioning, the host computer 6 sends the switchover control signal SS to the input switchover unit 86 in order to switch its input-side switchover terminal to "2," i.e., the side of the connector box 85B (corresponding to the preamplifier group 84B). At this positioning and under this input switchover state, the second scan is carried out in the same way as the above. As a result, only an echo signal detected by the second coil group 2 is received and processed by the receiving-system circuit 87, the resultant echo data being given to the host computer 6. By this host computer 6, the echo data are reconstructed to image data.

[0054]

In the similar manner to the above, the tabletop 14T is further moved in the Z-axis direction by a distance corresponding to the region required for one time of imaging. In parallel with this, the input-side switchover terminal of the input switchover unit 86 is switched over "3," (that is, the preamplifier group 84C). In this situation, the third scan is carried out in the similar manner to the above. Accordingly, only an echo signal detected by the third coil group 3 is received and processed by the receiving-system circuit 87, thereby resultant echo data being sent to the host computer 6. The echo data are reconstructed into image data by the host computer 6.

[0055]

In this way, the multiple RF coil 7R is used as a reception RF coil to perform each time of scan based on the moving bed technique. After the acquisition of echo data, the host computer 6 synthesizes a plurality of images that have been reconstructed in response to echo signal detection using each coil group 1 (to 3) into an entire image with their positions in the X-axis direction made to agree with each other. This produces, for example, a coronal image that covers the entire inferior limb.

[0056]

Therefore, in the MRI system according to the present embodiment, the single receiving-system circuit is enough even when a

plurality of coil groups 1 to 3 constituting the multiple RF coil 7R. It is therefore possible to reduce the number of receiving-system circuits that conventional. Particularly, the capacity of a memory buffer incorporated in the receiving-system circuit can largely be lowered in number. Further, because it is not necessary for an operator to manually set a tabletop's position with the position observed by the operator, the operation is simplified greatly and the tabletop can be located at a desired position with precision. In addition, this way of automatic tabletop movement enables the imaging to speed up.

[0057]

On the contrary, in the conventional construction shown in Fig. 13, all echo signals detected by all the coil groups of the multiple RF coil are sent to the host computer via the individual receiving-system circuits. This configuration will still do if the number of coil groups is less, but if each coil group adopts a large number of coil elements, the number of receiving-system circuits increases correspondingly to that of coil elements. The capacities of buffer memories temporarily storing A/D-converted echo data should be extremely large. For instance, if three coil groups are used, each coil group (array coil) consisting of four-channel array types of coil elements, a total of 12-channnel receiving-system circuits are required. By contrast, it is enough for the receiver 8R according to the present embodiment to use only one receiving-system circuit, expecting that preamplifiers are prepared for each coil element of each coil group and one input switchover unit is prepared. The largeness of the circuit is lowered to a grater degree.

[0058]

(Second embodiment)

Referring to Fig. 2, a second embodiment of the present invention will now be explained. This embodiment is characteristic of the foregoing input switchover unit 86 switching over according to levels of echo signals.

[0059]

In an MRI system which is shown by Fig. 2, the reception part for the multiple RF coil in the receiver 8R employs signal level detectors 88A to 88C. Each of the detectors is inserted, coil group by coil group,

between each of the connector boxes 85A to 85C and each the preamplifier groups 84A to 84C. Each signal level detector 88A (to 88C) detects levels (amounts of power) of echo signals emanated from each coil group 1 (to 3). Detected signals SC from those detectors 88A to 88C are sent to the host computer 6.

[0060]

The multiple RF coil 7R is entirely moved step by step along the Z-axis direction every each time of imaging. Accordingly, the coil groups 1 to 3 enter the uniform region of the static field in a certain direction in turn and go out of the region in the opposite direction in turn. Hence an echo signal from a certain coil group existing in the uniform region is higher in intensity than that from the remaining coil groups that are not present in the uniform region. The host computer 6 accepts the detected signals SC form the signal level detectors 88A to 88C to determine their signal levels. Specifically, a certain coil group that provides the highest signal level is selected. The host computer 6 then provides the input switchover unit 86 with the switchover control signal SS so as to switch the input switchover unit 86 in such a manner that the echo signal from the selected coil group is sent to the receiving-system circuit 87.

[0061]

The remaining configuration and imaging manners using the moving bed technique are identical to those in the first embodiment.

[0062]

As described above, the reception path is automatically switched based on the levels of the signals from the coil groups 1 to 3. Accordingly, like the foregoing embodiment, the single receiving-system circuit is enough to the multiple RF coil 7R. The configuration of the system can be simplified and compacted to a larger extent.

[0063]

It is unnecessary to set an amount of movement of the couch for every time of imaging. Also it is unnecessary to know information about when each coil group was present in the uniform region of the static field (the region for diagnosis). Even when the lengths of the coil groups 1 to 3 in the Z-axis direction are different from each other and/or the coil groups are disposed to be oblique to the Z-axis direction,

such automatic switchovers can be done, thus substantially saving labor for operations.

[0064]

In addition, in the MRI system of this embodiment, an alternative control is possible. That is, the movement of the tabletop 14T can be controlled using echo signal levels detected when respective coil groups 1 to 3 existed in the uniform region of the static field with the Z-axis directional center of each coil group placed at the center of the region. Practically, as the sequencer 5 executes a positioning scan periodically, the host computer 6 controls the Z-axis directional movement of the tabletop 14T. Until the detected signals from the signal level detectors 88A to 88C reach a predetermined signal level, the tabletop 14T, that is, the multiple RF coils 7R, which is located at its predetermined initial position, is moved every time of imaging. This allows the tabletop 14T to be moved in an automatic function.

[0065]

This automation makes it possible that the tabletop 14T is moved in a controlled manner independently of the Z-axis directional sizes of the coil groups or arranged situations of the coil groups. For example, such cases include a situation that the coil groups 1 to 3 composing the multiple RF coil 7R are made into different sizes that agree with each part of an object, respectively, thus the Z-axis directional sizes of the coil groups being different from each other. Further included is a situation that the Z-axis directional sizes of all the coil groups are equal to each other, but each coil is not necessarily disposed in position in the Z-axis direction. That is, even if the coil groups are mutually different in the Z-axis directional substantial or apparent sizes, each coil group can be located in turn in the center of the uniform static field region in the Z-axis direction every time of imaging. This automatic control of the tabletop reduces operator's operations drastically.

[0066]

(Third embodiment)

Referring to Figs. 3 to 5, a third embodiment of the present invention will now be described. This embodiment relates to another

example to detect the positions of coil groups that composes a multiple RF coil.

[0067]

Fig. 3 shows an essential part of a receiver 8R of an MRI system according to this embodiment. As shown therein, ID generators 7A to 7C are placed in a plurality of coil groups 1 to 3 that composes a multiple RF coil 7R, respectively. Each of the ID generators 7A to 7C is for example a two-bit dip switch. The dip switch is not always limited to 2 bits. As shown in Fig. 4, each dip switch generates identifying information indicative of the type and coil size of each coil group depending on its switched positions. The type of coil group includes a surface coil, QD coil, while the size of coil group includes the largeness of length in the Z-axis direction. The relationships between the switched positions and the identifying information for each coil group are previously stored as tables in an inner memory of the host computer 6.

[0068]

As each coil group (consisting of a plurality of coil elements disposed in an array), coil elements of a desired type and a size are selected appropriately, then disposed along the Z-axis direction, that is, along an object P or the tabletop 14T. A plurality of disposed coil groups 1 to 3 compose a multiple RF coil 7R. For instance, if a region to be imaged is the inferior limb, the coil groups of appropriate types and sizes are selected according to the shape and size of each part of the inferior limb. It is not absolutely necessary to dispose the coil groups along the geometrical Z-axis. By way of example, a certain coil group may be disposed along the femur part, thus slight oblique to the Z-axis direction.

[0069]

The plurality of coil groups 1 to 3 disposed as above are connected to slots 1 to 3 of a connector box 85 in the order of the disposition. For example, the wires W1 of the first coil group 1 which is to be located nearest to the patient's head are connected to the first slot 1 (, the wires W1 including a signal line from the ID generator 7A and signal lines from the coil elements). The second and third coil groups 2 and 3 are connected in the similar way, so that their wires W2

and W3 are connected to the slots 2 and 3 in turn. In this way, the coil groups 1 to 3 can simply be connected to the slots 1 to 3 of the connector box 85 in the disposed order of the coil groups, independently of types and sizes of the coil groups 1 to 3.

[0070]

Of the output signal terminals of the connector box 85, the signal lines responsible for outputs of the coil groups 1 to 3 are routed to the receiving-system circuit 87 via the input switchover unit 86, as shown in Fig. 2. Meanwhile, the signal lines responsible for outputs of the ID generators 7A to 7C are coupled with the host computer 6.

[0071]

The host computer 6 executes control represented in Fig. 5 using the switch signals from the ID generators 7A to 7C, in other words, identifying information of the coil groups. Specifically, the host computer 6 reads the switch signals, and then makes reference to the previously-stored table exemplified in Fig. 4 to determine a disposal order of the coil groups 1 to 3 and the type of each coil group (Step S1 and S2). The host computer 6 obtains the sizes of the coil groups through, for example, making reference to the table and amounts of movement of the coil groups 1 to 3 that should be moved for each time of imaging are calculated based on the obtained sizes (Step S3).

[0072]

On completion of this preparation, the host computer 6 begins to wait for the next action as it determines whether timing for imaging has come or not. During the waiting, if imaging timing is detected, the host computer controls a not-shown couch driver so that the tabletop 14T is moved by a distance corresponding to the first movement amount (Steps S4 and S5). Then, it is determined whether or not all the imaging has completed or not, and if imaging remains, the processing at Steps S4 and S5 will be repeated (Step S6). This repetition leads to the second and third imaging that also involves the movement of the multiple RF coil 7R (that is, the coil groups 1 to 3). After the completion of all the times of imaging, the tabletop 14T is controlled such that it returns to its initial position predetermined in the Z-axis direction (Step S7).

[0073]

In this embodiment, it is therefore unnecessary for an operator to pay a particular attention to the relationship between types and sizes of the coil groups to be used and movement amounts on the moving bed technique. Identifying information provided by the ID generators 7A to 7C can be used to automatically calculate movement amounts of the tabletop 14T. Thus, the tabletop movement is automatically controlled, during which time the input switchover unit 86 is automatically switched over in response to each time of imaging. Accordingly, an echo signal detected by only a certain coil group 1 (to 3) located in the uniform static field region is received for imaging.

[0074]

Based on the moving bed technique involving the multiple RF coil 7R, an MR image can therefore be obtained over a wired area. Concurrently, a great deal of labor can be saved for operator's operations.

[0075]

A modified example from the above will now be described with reference to Fig. 6. This example, applicable to the foregoing embodiment, relates to a technique of determining accurate amounts of movement of the tabletop (that is, amounts of movement of the multiple RF coil) from positioning information toward the first coil group.

[0076]

Practically, a marker MK showing the central position of each of the coil groups 1 to 3 in the Z-axis direction is put on the coil groups. At first, a light projector is spotlighted onto the marker MK to assign the central position of each coil group to predetermined positions of a couch's positional encoder. Then the light projector is used to locate its spotlighted position Pz to a desired region to be diagnosed of a patient, before the position Pz is memorized. A coil size Ln is found from the identifying information of each coil group. Subtracting a length A between the spotlighted position Pz and the coil center from half of the coil size Ln gives the residual length from the current position Pz to the first coil group with precision. Accordingly, the coil groups can be disposed at any position on the couch. Even when the central position of each coil group is not always consistent with an actually spotlighted position, the tabletop can be moved with precision.

[0077]

A further modification will now be described, which is also applicable to the foregoing embodiment. This modification provides another configuration to detect the position of each coil group. To be specific, a minute pickup coil is disposed at the center of each of a plurality of coil groups. With the coil groups shifted by a predetermined distance from the center of the uniform static field region, a measuring gradient pulse of a predetermined magnitude is given to the coil groups. This previously provides the relationships between the known shifted distance and output signal values of the pickup coils. The output signal values can be given as waveform height values of output waveforms calculated using an integrator. In imaging, in cases the positions of the coil groups are desired, the measuring gradient pulse is applied to the pickup coils to detect output signals therefrom, thus providing the Z-axis directional positions of the coil groups. Imaging on the moving bed technique with the pickup coils requires that the pickup coils be able to detect the Z-axis direction gradient pulse.

[0078]

Further, in cases where the multiple RF coil is made up of a plurality of coil groups, such as surface coils, to which attention must be paid with regard to problem of a spatial disposal, a pickup coil for the orthogonal three directions is attached to a support of each coil group. In this case, the measuring gradient pulse is applied in sequence in the three directions. Using the previously obtained positional relationship between each coil center and its support, output signals of the pickup coils are corrected.

[0079]

(Fourth embodiment)

Referring to Fig. 7, a fourth embodiment of the present invention will now be described. This embodiment concerns fast imaging using a multiple RF coil on the basis of the moving bed technique.

[0080]

Fig. 7 pictorially shows the positional relationship between a multiple RF coil 7R and sensitivity regions of coil groups thereof in an

MRI system according to the present embodiment. As shown, the coil groups 1 to 3 of the multiple RF coil 7R are disposed along the Z-axis direction. Responsively to the movement of the tabletop 14T, the three coil groups 1 to 3 are also moved in the Z-axis direction.

[0081]

Echo signals detected by the coil groups 1 to 3 are sent to a receiver of which circuitry is constructed in the same way as that in any of the first to third embodiments, in which the signals are processed by any of the foregoing processing ways. In this case, the foregoing input switchover unit is designed so that it allows two adjoining coil groups to simultaneously be coupled with the receiving-system circuit. The receiving-system circuit includes a set of circuits to process, coil element by coil element, the two echo signals emanated from the two coil groups. This makes it possible that the two echo signals are received and processed in parallel, before being sent, signal by signal, to a host computer as echo data.

[0082]

Commands issued from the host computer or sequencer permits the tabletop 14T to move along the Z-axis direction. Each of the coil groups 1 to 3 is located in the uniform static field region (a region to be diagnosed) every time of imaging, but in the present embodiment, there is no need to locate the center of a sensitivity region R_{sens} of each coil group at the center of the uniform static field region (not shown), differently from the ordinal moving bed technique. Instead, a region $R_{overlap}$ in which sensitivity distribution regions R_{sens} of two adjoining coil groups are mutually overlapped is set in the uniform static field region in order to perform imaging.

[0083]

Each time of scan is carried out on half of the number of steps of encoding necessary for reconstructing a single image. Every time when each time of scan is ended, the couch is moved for the next scan by a distance for one time of scan, the distance being able to be scanned by one coil group. This combination of the scan and the couch movement is repeated to scan an entire region to be desired.

[0084]

More practically, this imaging can be carried out based on a

conventional known technique of fast imaging using a multiple RF coil. Such technique has been provided by, for example, "10th, Ann. Scientific Meeting SMRM. 1240, 1991." Reducing the number of encoding steps than that necessary for a signal image will result in an image with aliasing. But the above processing technique includes calculation to remove the aliasing. In other words, the fact that the coil sensitivity distributions of the coil groups are different from each other is utilized to decompose the aliasing through post-calculation, then the aliasing is removed from the image.

[0085]

Accordingly, the present embodiment enables the fast imaging to be performed using the moving bed technique. In particular, through the multiple RF coil is used, a plurality of sets of coil elements (sets) that composes the multiple RF coil are automatically moved (tabletop movement) and positioned, in addition to automatic switchovers between the coil sets. Therefore, all the advantages of the fast imaging can be provided, with fewer operators burden on operations.

[0086]

In cases where, as described above, the fast imaging with the multiple RF coil is conducted under the moving bed technique, the number of encoding steps can be lowered in inverse proportion to the number of coil elements. Thus, imaging time is reduced and a fully high speed of imaging is maintained.

[0087]

(Fifth embodiment)

Referring to Fig. 8, a fifth embodiment of the present invention will now be described. This embodiment relates to the disposal of a multiple RF coil.

[0088]

As shown in Fig. 8(a), (b), a multiple RF coil of this embodiment is disposed as far apart as possible from the tabletop 14T of a couch or the surface of an object P. Specifically, the multiple RF coil 7R consists of three coil groups 1 to 3. Each coil group 1 (to 3) consists of an array type of upper coil group 1 (to 3) and an array type of lower coil group 1 (to 3). The upper coil group 1 (to 3) has two coil elements $7U_1$ and $7U_2$

located above the upper side of the tabletop and supported by a common coil supporter 30U. The lower coil group 1 (to 3) has two coil elements $7L_1$ and $7L_2$ located below the lower side of the tabletop and supported by a common coil supporter 30L.

[0089]

Compared to the multiple RF coil shown in Fig. 7, this disposal widens the sensitivity distribution region R_{sens} of each coil group, thus widening an overlapped region $R_{overlap}$ of the sensitivity distribution regions between adjoining coil groups. If a region to be imaged is the same in area, the above disposal allows imaging to be accomplished with a less number of coil groups.

[0090]

(Sixth embodiment)

Referring to Fig. 9, a sixth embodiment of the present invention will now be described. This embodiment is concerned with a configuration that employs a whole-body (WB) coil as multiple RF coils.

[0091]

As shown Fig. 9, there is a whole-body coil 7 composed of an array of multiple coils, which are configured by placing three short-axis whole-body coils 7a, 7b and 7c in an array. The number of disposed coils may be at least two.

[0092]

The respective whole-body coils 7a, 7b and 7Tc are connected to respective preamplifiers 32a, 32b and 32c via a duplexer 31 in a receiver 8R. The preamplifiers 32a, 32b and 32c are connected to a host computer 6 by way of receiving-system circuits 33a, 33b and 33c. These configurations enable echo signals detected by the whole-body coils 7a, 7b and 7c to be received and processed independently of each other. The transmitter 8T is coupled with the whole-body coils 7a, 7b and 7c via the duplexer 31, so that transmission can be done.

[0093]

Alternatively, the multiple whole-body coils can be reduced into a configuration shown in Figs. 10(a), (b). A practical configuration is such that four-channel whole-body coils 34a, 34b, 34c and 34d are disposed in a periphery direction, thus the coils being multiple. In this

configuration, if the sensitivity distributions are symmetric, there are some cases where reconstruction is impossible. The coils are thus disposed in asymmetric manners in the lateral and longitudinal directions.

[0094]

(Seventh embodiment)

Referring to Fig. 11, a seventh embodiment of the present invention will now be described. This embodiment relates to a system in which fast imaging that involves couch movement is performed using a single whole-body coil.

[0095]

The fast imaging described by the foregoing paper requires, as the principle, N-piece coils (coil elements) to reduce the number of encoding steps down to 1/N. As a result, an MRI system that comprises a single whole-body coil, as seen in conventional systems, has a problem that the fast imaging cannot be performed.

[0096]

The present embodiment overcomes this difficulty. Even if only a single whole-body is incorporated in the system, sensitivity distributions of a whole-body coil can be changed by moving the couch. This is equivalent to the situation that the same region of an object is scanned with different sensitivity distributions of coils. Based on this fact, the couch movement is unitized in the present embodiment, so that the fast imaging based on the principle of reducing the number of encoding steps is conducted.

[0097]

According to the simplest example, at first, the number of encoding steps necessary for reconstructing a single image is reduced down to half at a certain couch position, and then scans are performed at the couch position. This provides a single image of a given region to be imaged at the first couch position. The couch tabletop is then moved by a predetermined distance (for example, a distance that corresponds to half of a length of the whole-body coil in the Z-axis direction). Like the above, in order to obtain a further image, the same region of the object is subject to scans with half of the number of

encoding steps. Namely, moving the couch tabletop by the given distance is equivalent to the situation that there are virtually two whole-body coils (refer to Fig. 11). The whole-body coil is apparently two in number to a given region to be imaged of the object, even if only a single whole-body coil is adopted.

[0098]

Each of the images obtained by the two times of imaging causes an aliasing phenomenon in each image. However, since being equivalent to two images obtained with whole-body coils of different sensitivity distributions, a single original image is reconstructed, from which the aliasing is removed by calculation based on the technique that the foregoing paper provides.

[0099]

In particular, the imaging according to the present embodiment is preferable to an ultra short-axis type of MRI system. This system, which comprises a single whole-body coil, requires several times of imaging to obtain an image of an ordinal region to be imaged in the Z-axis direction, because the axial length in the Z-axis direction is shorter. The imaging according to the present embodiment can be applied to this system. For instance, the read-out direction is assigned to the Z-axis direction, an FOV in the Z-axis direction is doubled (which is for example the same as the FOV of a region to be imaged by the conventional long-axis type of MRI system), the number of encoding steps is reduced down to half, and the couch is moved, each time of imaging (in total, two times of imaging), by a distance corresponding to one region scanned by the conventional MRI system. This makes it possible to perform sagittal and coronal imaging, which was difficult for the ultra short-axis type of system, in the same period of time as that for the ordinal MRI.

[0100]

In addition, the couch movement and image processing for the foregoing single whole-body coil may be applied to the foregoing configuration of Fig. 9 in which the multiple RF coils are used. Further, such couch movement and image processing are also applicable to the configuration of the multiple RF coils whose positions are fixed as shown in Fig. 8.

[0101]

The present invention will not be construed to be limited to the foregoing typically exemplified embodiments and modifications, and the person skilled in the art may deform or alter the configurations in various modes without departing from the gist of the present invention described in the claims.

[0102]

[Effect of the invention]

As described above, the MRI system and MR imaging method according to the present invention employ multiple RF coils as a reception RF coil to perform imaging based on the moving bed technique, in which operations for switching the coils during the movement of a couch are unnecessary, whereby labor-saving in the operations becomes unnecessary, imaging is speeded up, and the couch is moved with more accuracy.

[0103]

In addition, in the present invention, multiple RF coils can be used as a reception RF coil to perform imaging based on the moving bed technique, in which fast imaging can easily be done with temporal resolution improved, thus being able to provide MR images of a higher depiction performance.

[Brief description of the drawings]

[Fig. 1] Fig. 1 shows a block diagram outlining the configuration of an MRI system according to a first embodiment of the present invention, the system being directed to imaging using multiple RF coils on the moving bed technique.

[Fig. 2] Fig. 2 shows a block diagram outlining the configuration of an MRI system according to a second embodiment of the present invention, the system performing imaging using multiple RF coils on the moving bed technique.

[Fig. 3] Fig. 3 shows a block diagram outlining part of the configuration of an MRI system according to a third embodiment of the present invention, the system performing imaging using multiple RF coils on the moving bed technique.

[Fig. 4] Fig. 4 illustrates the relationship between the switch positions of an ID generator and pieces of coil information.

[Fig. 5] Fig. 5 is a flowchart outlining tabletop movement control based on information given by the ID generator.

[Fig. 6] Fig. 6 illustrates markers used for recognizing the position of a coil element, which shows a modification.

[Fig. 7] Fig. 7 is an outlined schematic diagram showing part of an MRI system according to a fourth embodiment of the present invention, the system performing fast imaging using multiple RF coils with a couch moved.

[Fig. 8] Fig. 8 is an outlined schematic diagram showing part of an MRI system according to a fifth embodiment of the present invention, the system performing fast imaging using multiple RF coils with a couch moved.

[Fig. 9] Fig. 9 is an outlined schematic diagram showing an MRI system according to a sixth embodiment of the present invention, the system performing fast imaging using multiple whole-body coils with a couch moved.

[Fig. 10] Fig. 10 illustrates the configuration of multiple whole-body coils according to a modification.

[Fig. 11] Fig. 11 is an illustration of coil positions and a region to be imaged realized by fast imaging according to a seventh embodiment of the present invention, the imaging being performed using a single whole-body coil with a couch moved.

[Fig. 12] Fig. 12 is an outlined block diagram of a conventional MRI system for imaging carried out using a whole-body coil on a moving bed technique.

[Fig. 13] Fig. 13 is an outlined block diagram of a conventional MRI system for imaging carried out using multiple RF coils on the moving bed technique.

[Explanations of letters or numerals]

1	magnet
2	static power supply
4	gradient amplifier
5	sequencer
6	host computer
7R	multiple RF coils
7T	whole-body coil

7A – 7C ID generator
8R receiver
8T transmitter
11 storage
12 display
13 input device
14T tabletop of couch
14D couch driver
33a – 33d receiving-system circuit
34a – 34d coil element
85A – 85C, 85 connector box
86 input switchover unit
87 receiving-system circuit
88A – 88C signal level detector

[Name of document] Abstract

[Abstract]

[Problem] In cases where multiple RF coils are used as a reception RF coil and imaging is carried out based on a moving bed technique, labor-saving in the operations is achieved, imaging is speeded up, and a couch is moved with more accuracy.

[Solving means] There are provided couch moving means (14D) for moving a couch 14T on which an object P is laid, multiple RF coils 7R consisting of coil groups 1 to 3, and scan controlling means (6) for controlling operations of both scan means (4 - 6, 8T, 7T) and the couch moving means (14D) to have a region to be imaged of the object P scanned at a plurality of different positions of a couch. Furthermore, there are provided selection means (85A - 85C, 86, 6) for selecting, from a plurality of MR images received by the coil groups 1 to 3 of the multiple RF coils 7R, an MR signal used for image production and image producing means (87, 6) for producing an MR image from the selected MR signal.

[Chosen drawing] Fig. 1

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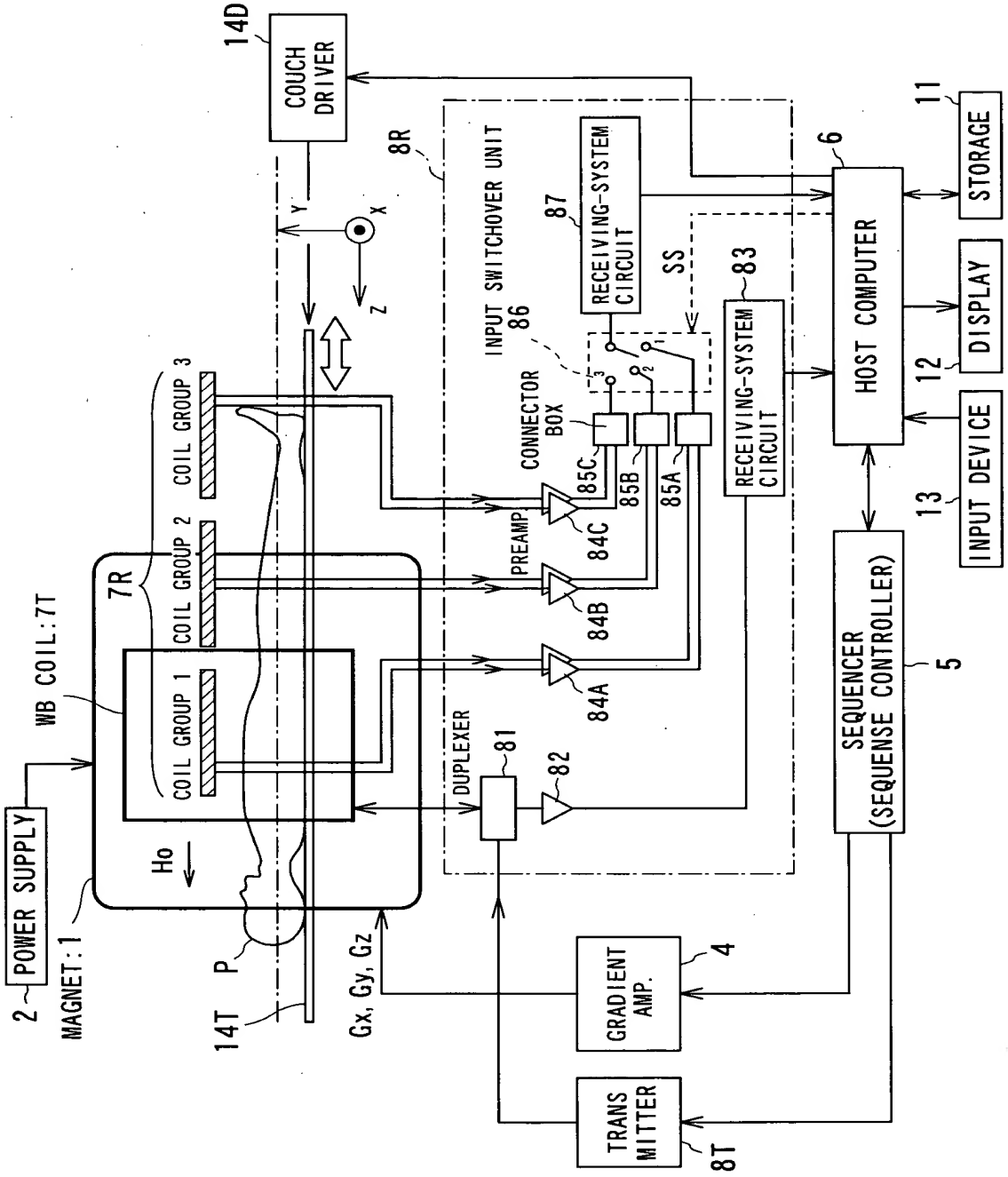

FIG. 1

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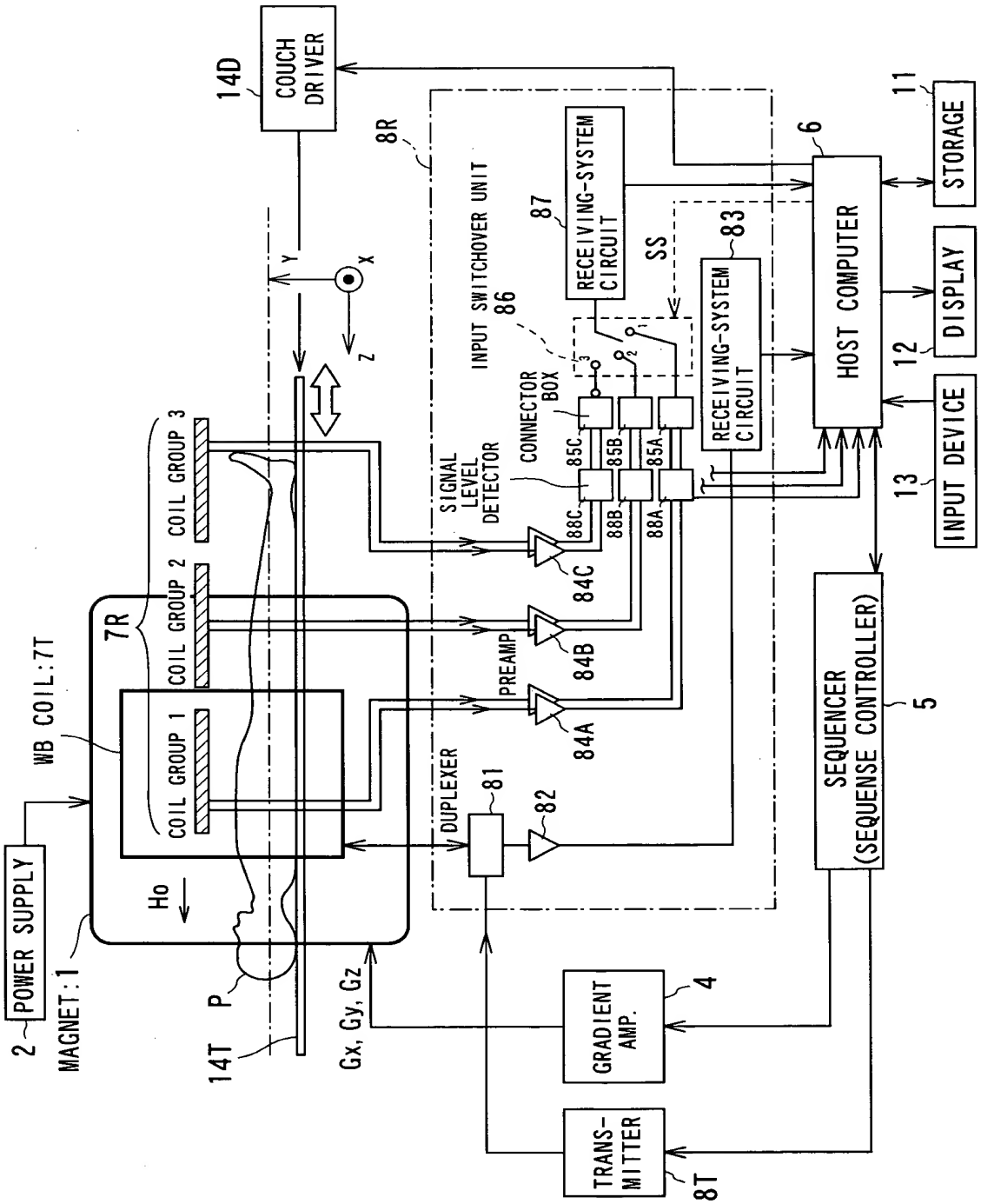

FIG. 2

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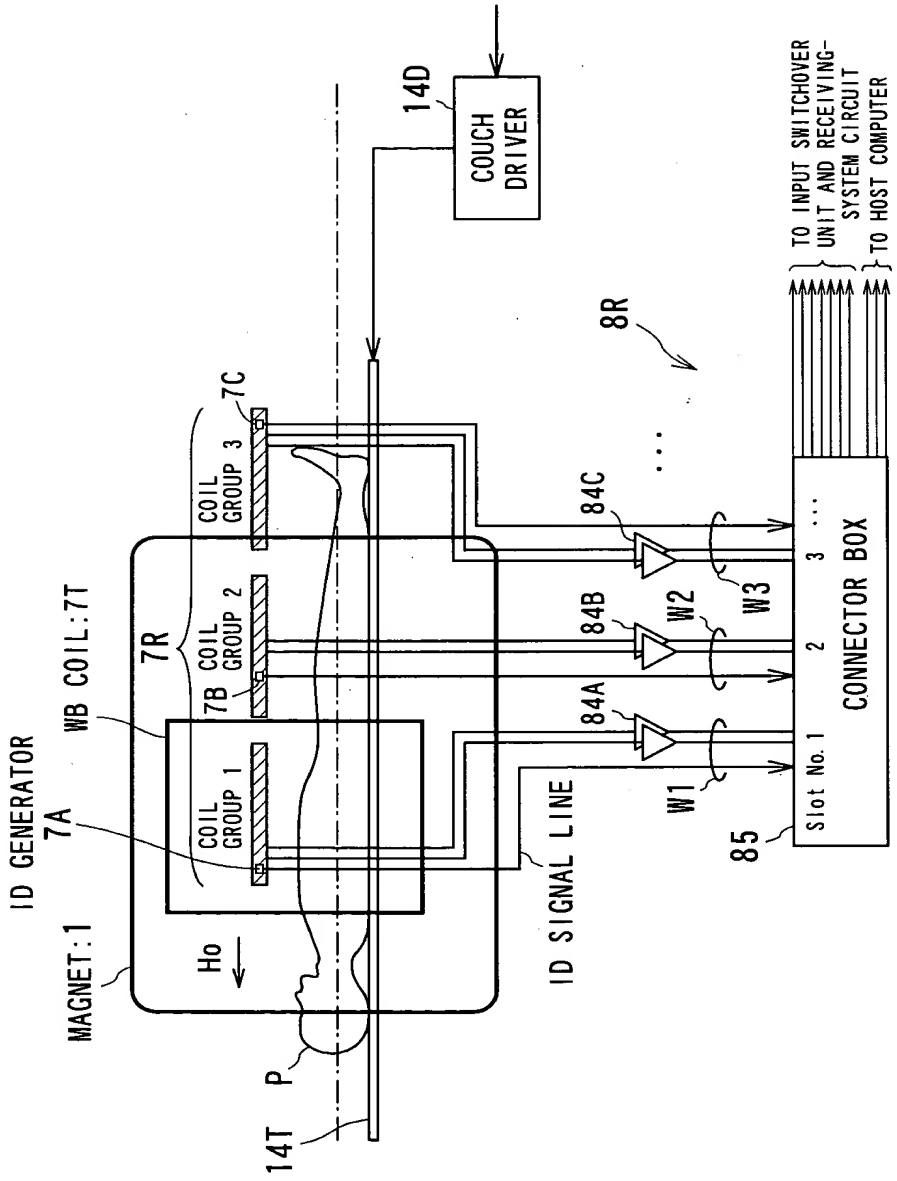

FIG. 3

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SWITCHED POSITION	TYPE OF COIL GROUP	SIZE OF COIL GROUP
0	×××	××
1	×××	××
2	×××	××
3	×××	××

FIG. 4

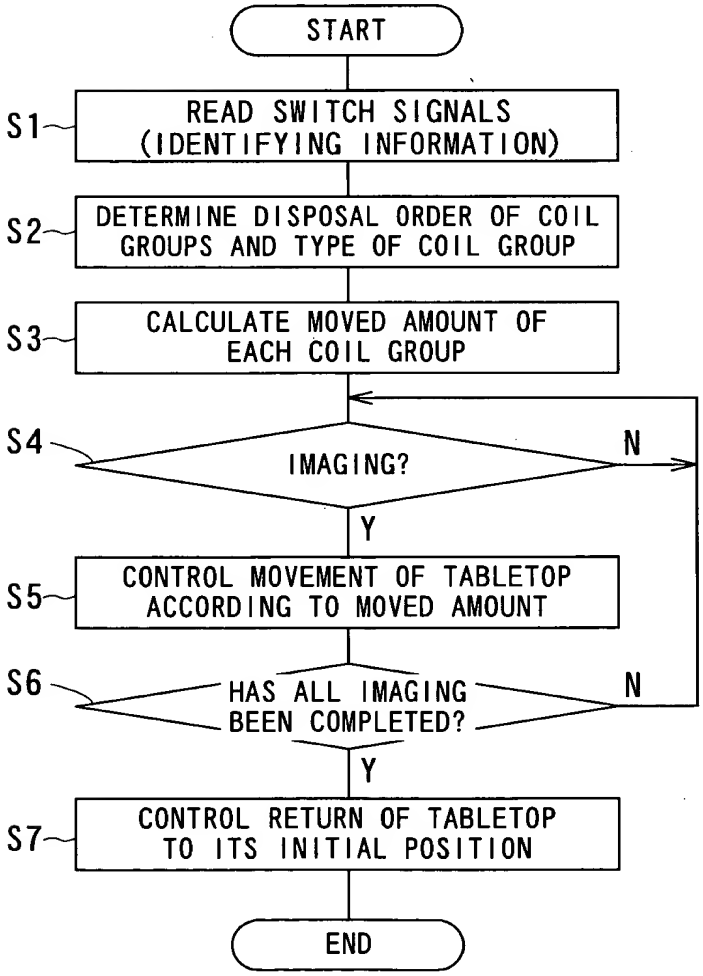

FIG. 5

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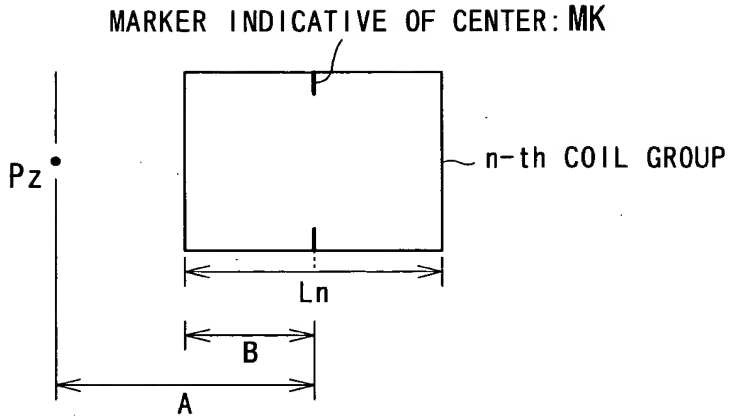

FIG. 6

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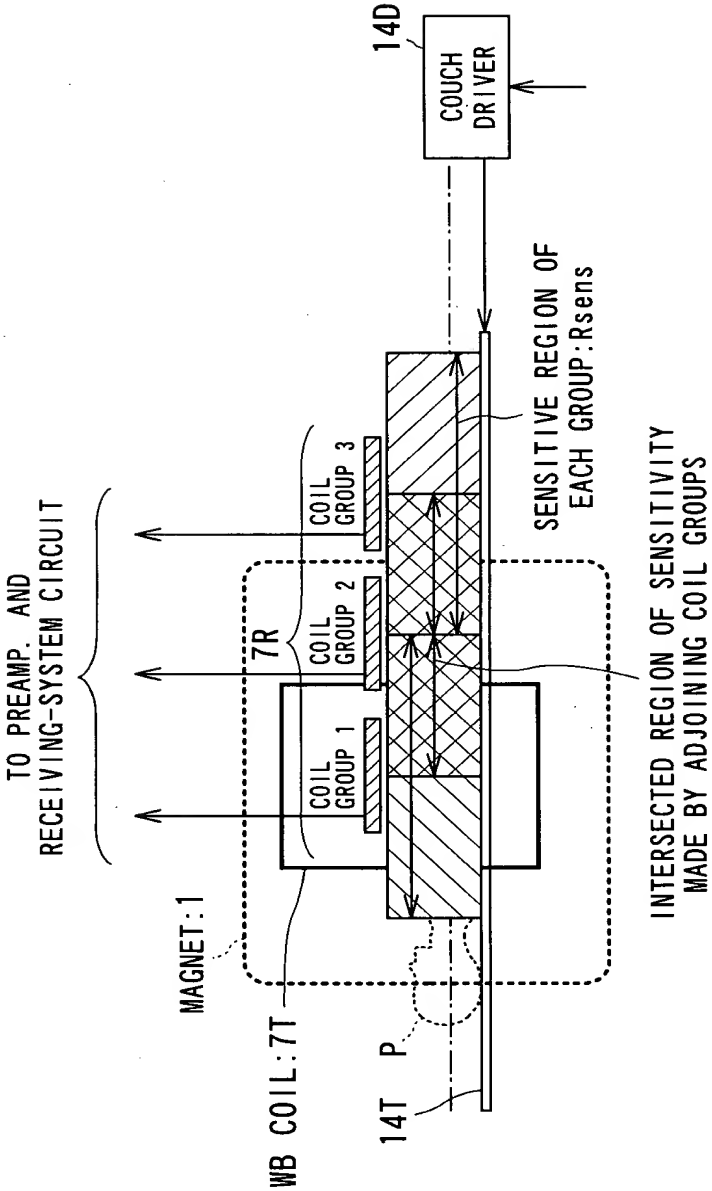

FIG. 7

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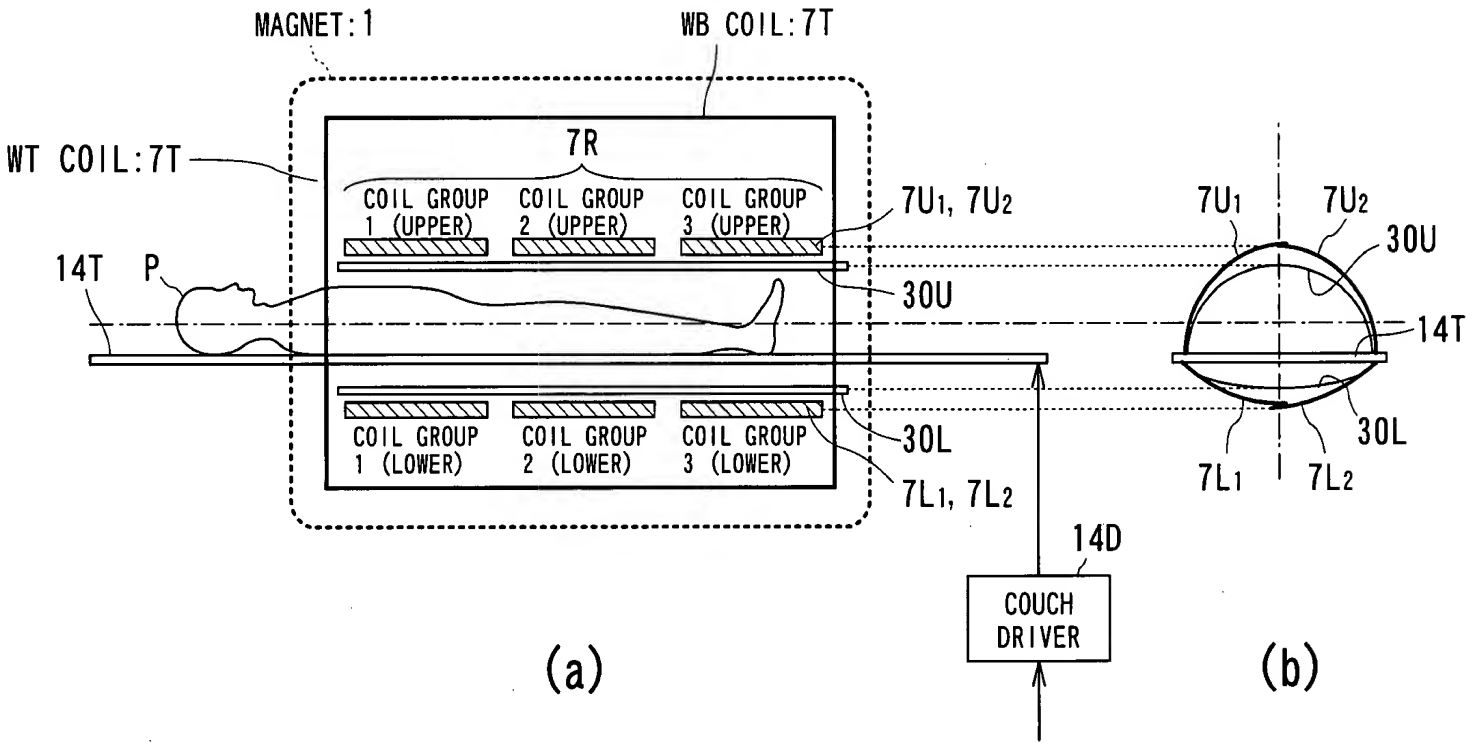

FIG. 8

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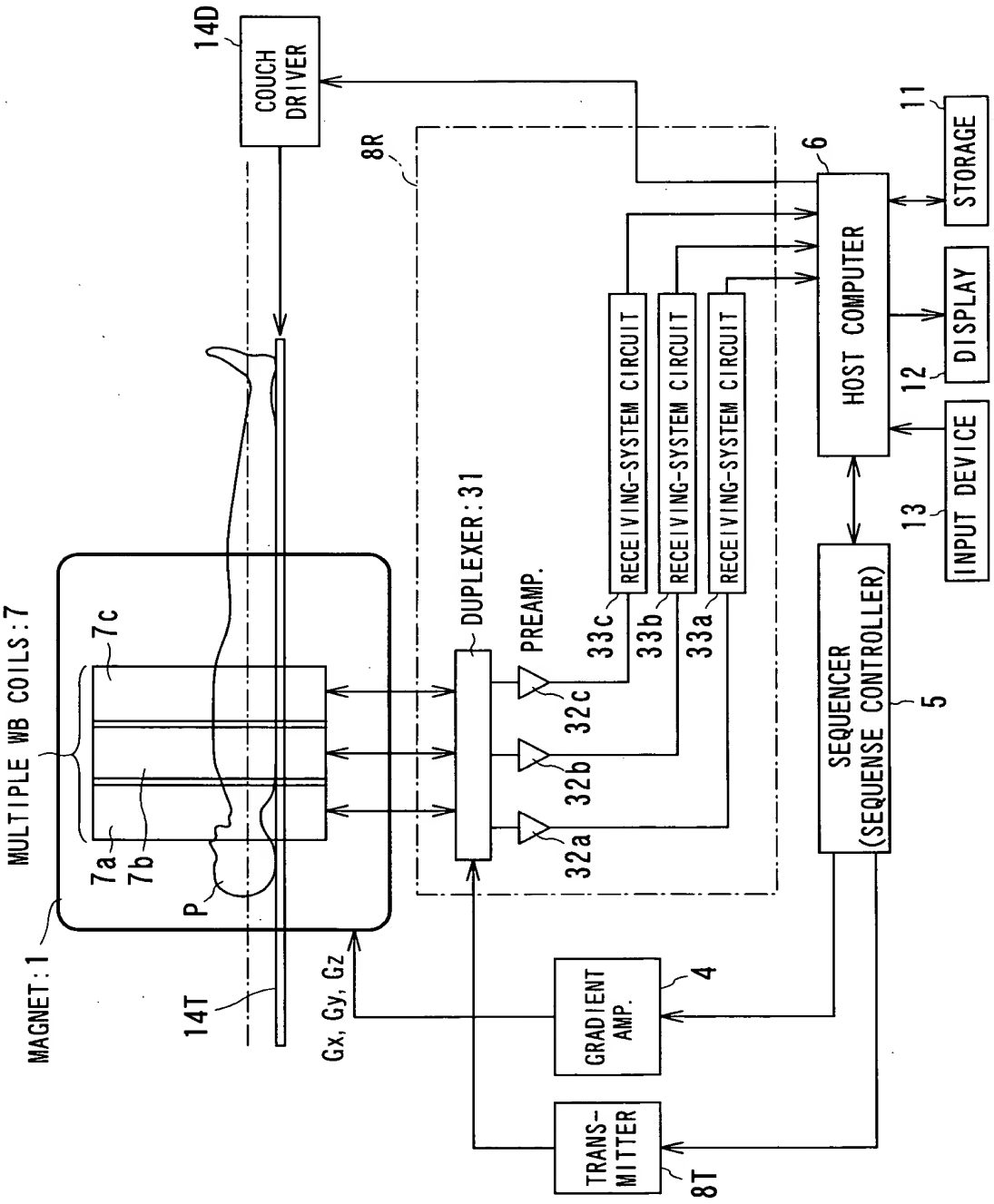

FIG. 9

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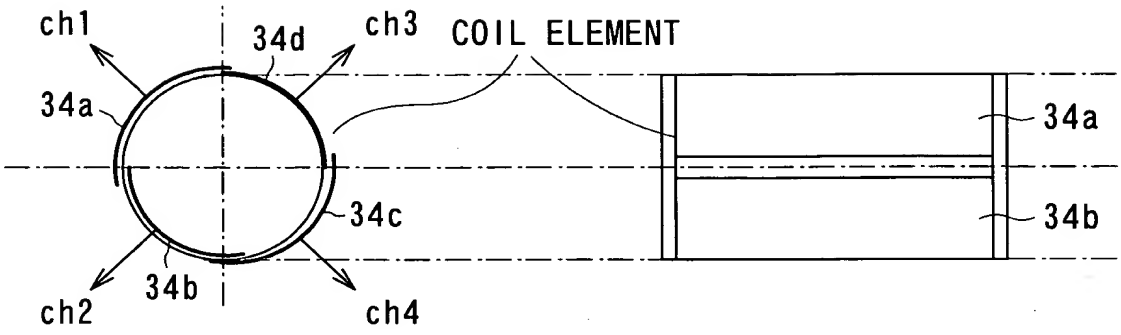

FIG. 10

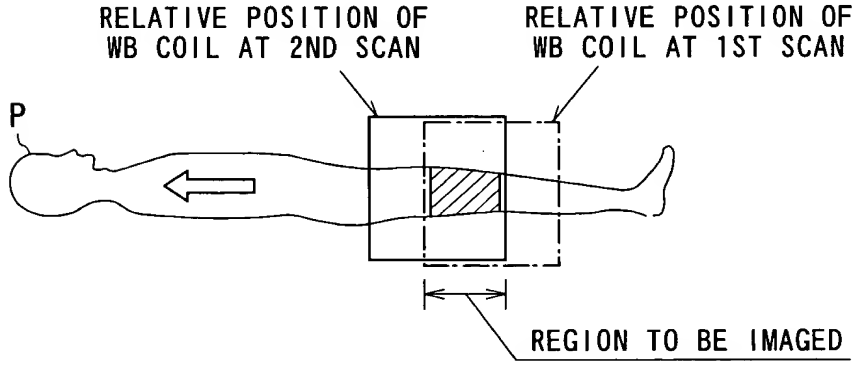

FIG. 11

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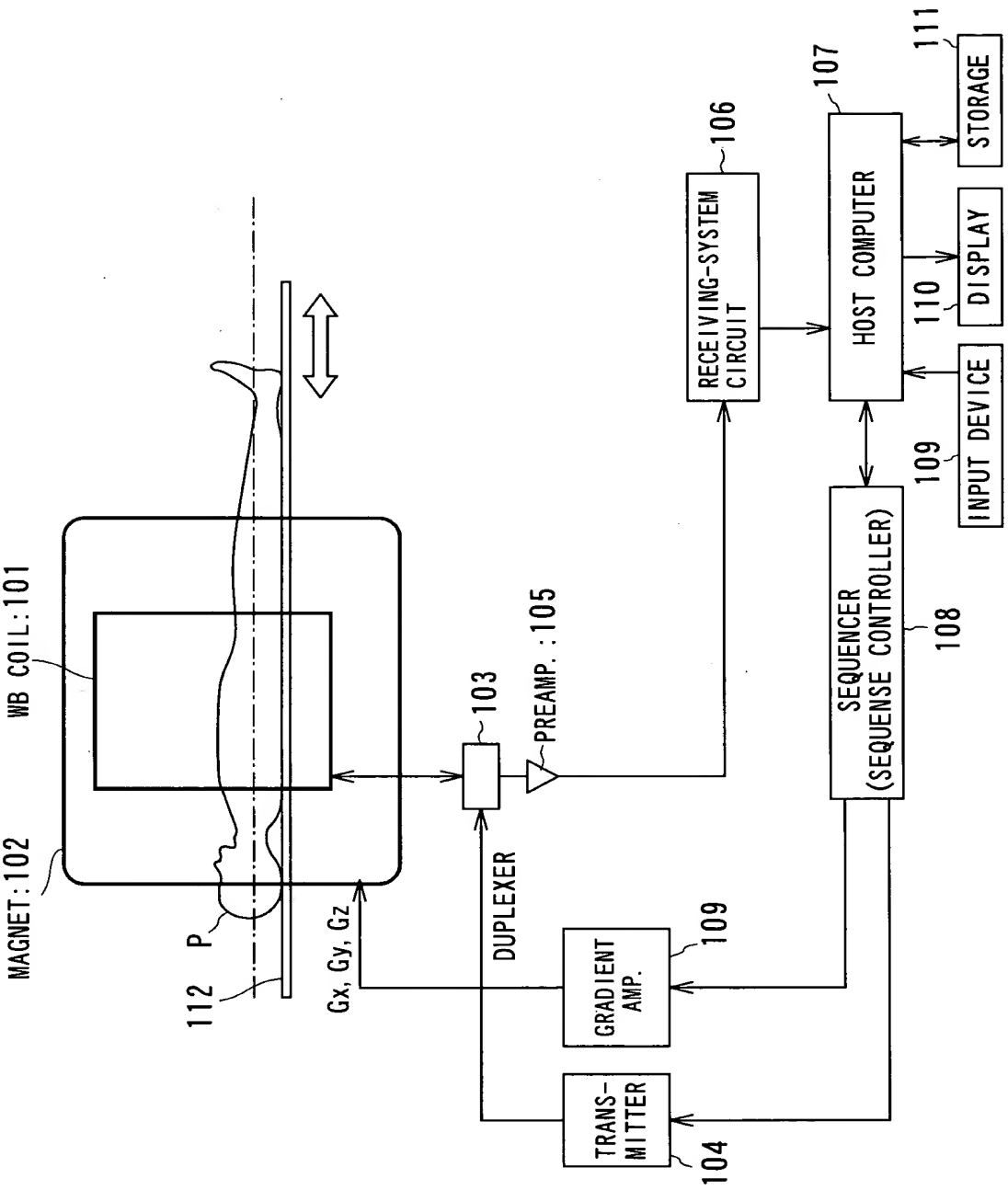

FIG. 12

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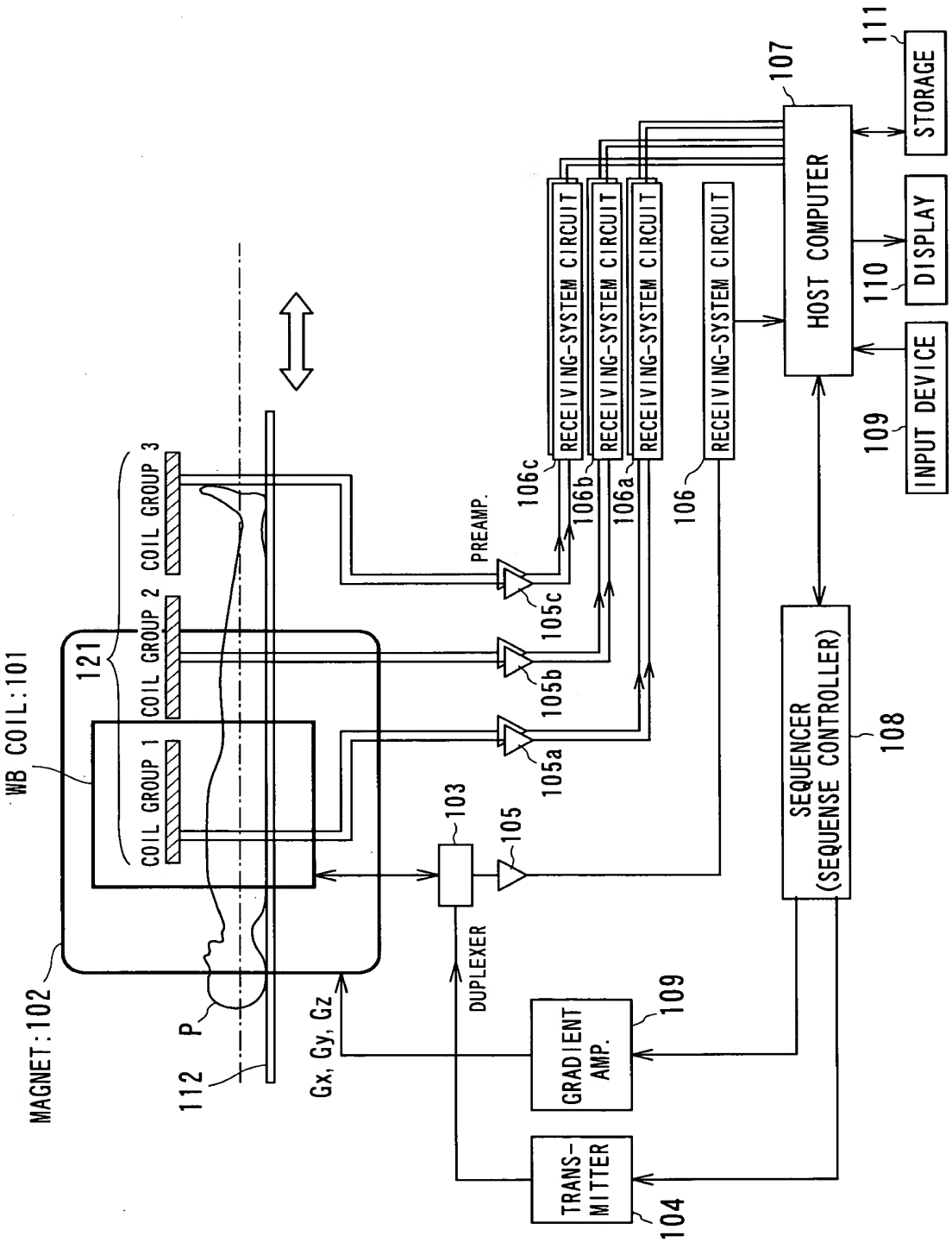

FIG. 13